Intelligent Software Agent Technology

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Computational Sciences and Engineering Division

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Successful Agent Projects

- We have extensive expertise in agent research
- Agent Team - 6 Computer Scientist PhDs
- DOE Q and SCI clearances

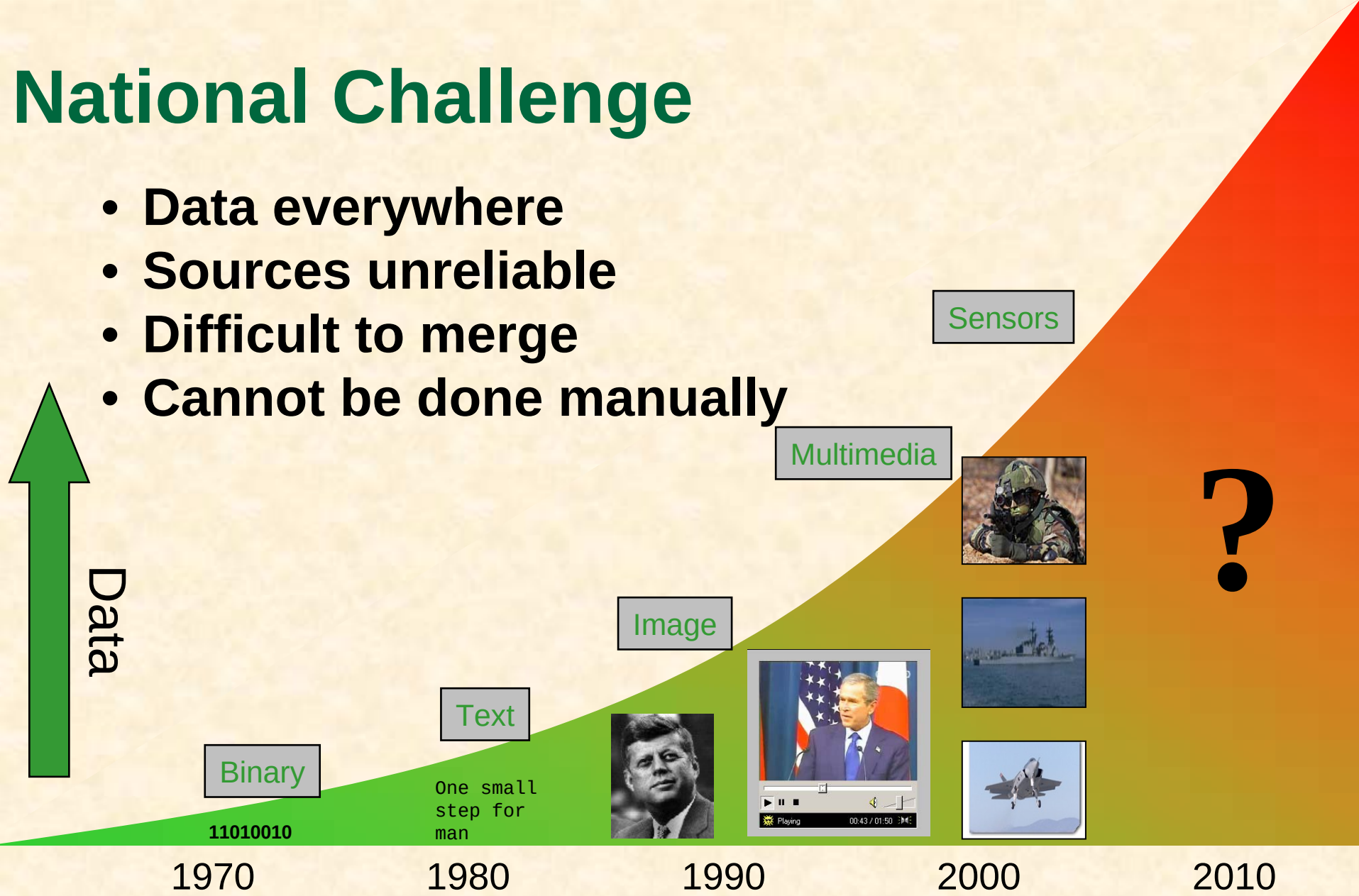
- Numerous successful projects within the several years

Recent Agent Papers and Workshops

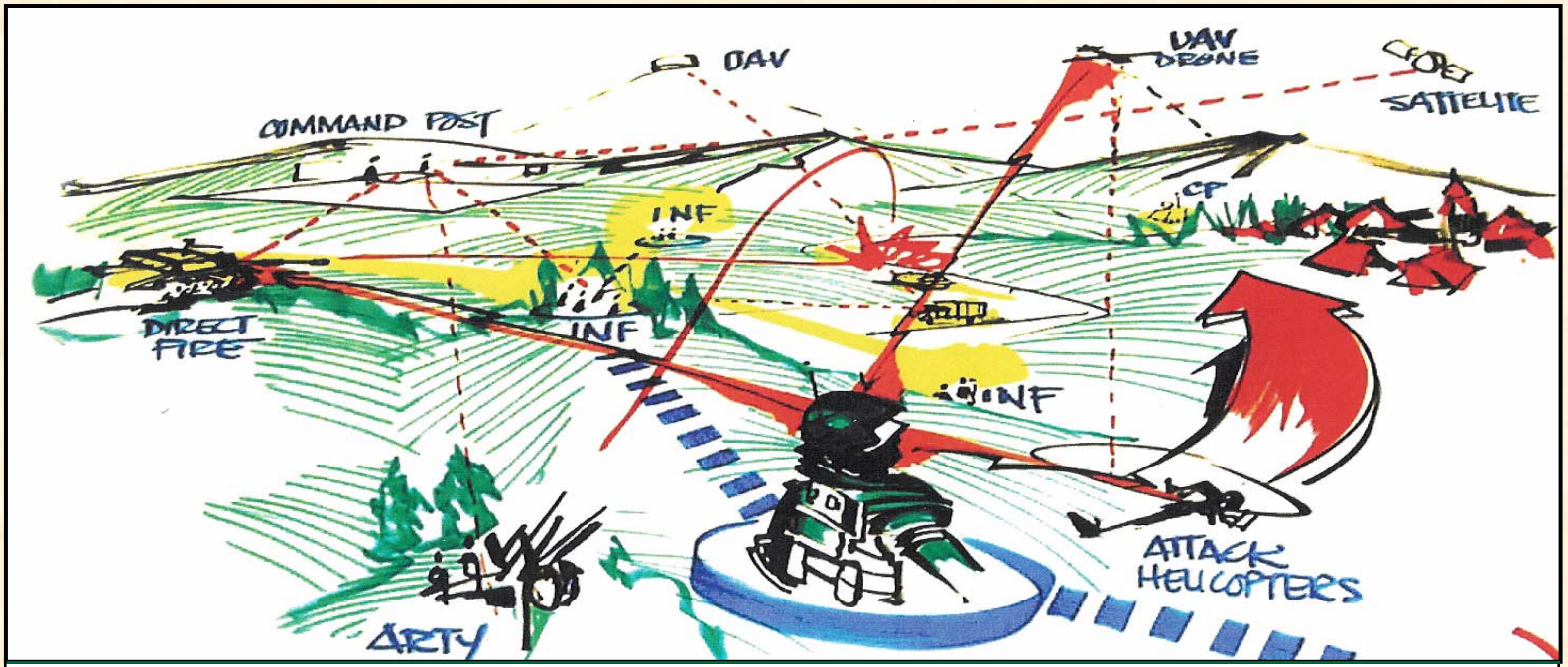
- ***Semantic Web: Structure & Critical Information Issues Workshop***
  - Thomas E. Potok and Mark Elmore Minitrack organizers at the *Thirty-seventh Annual Hawai'i International Conference On System Sciences*, 2004
- **Critical Energy Infrastructure Survivability, Inherent Limitations, Obstacles and Mitigation Strategies**
  - Frederick T. Sheldon, Tom Potok, Axel Krings and Paul Oman, *To Appear* *Int'l Journal of Power and Energy Systems –Special Theme Blackout*, ACTA Press, Calgary Canada, 2004
- **Managing Secure Survivable Critical Infrastructures To Avoid Vulnerabilities**
  - Frederick T. Sheldon, Tom Potok, Andy Loebl, Axel Krings and Paul Oman, *To Appear* *Eighth IEEE Int'l Symp. on HIGH ASSURANCE SYSTEMS ENGINEERING*, 25-26 March 2004, Tampa Florida.
- **Energy Infrastructure Survivability, Inherent Limitations, Obstacles and Mitigation Strategies**
  - Frederick T. Sheldon, Tom Potok, Andy Loebl, Axel Krings and Paul Oman, *IASTED Int'l Power Conference -Special Theme Blackout*, New York NY, pp. 49-53, Dec. 10-12, 2003
- **Multi-Agent System Case Studies in Command and Control, Information Fusion and Data Management**
  - Frederick T. Sheldon, Thomas E. Potok and Krishna M. Kavi, *Submitted* Aug. 18 *Informatica Journal* (ISSN 0350-5596) published by Slovene Society Informatika
- **Suitability of Agent Technology for Command and Control in Fault-tolerant, Safety-critical Responsive Decision Networks**
  - Thomas E. Potok, Laurence Phillips, Robert Pollock, Andy Loebl and Frederick T. Sheldon, *Proc.16th Int'l Conf. Parallel and Distributed Computing Systems*, Reno NV, Aug. 13-15, 2003
- **VIPAR: Advanced Information Agents discovering knowledge in an open and changing environment**
  - Thomas E. Potok, Mark Elmore, Joel Reed and Frederick T. Sheldon, Proc. 7th *World Multiconference on Systemics, Cybernetics and Informatics* Special Session on Agent-Based Computing, Orlando FL, July 27-30, 2003. **• • • Awarded Best Paper • • •**
- **An Ontology-Based Software Agent System Case Study**
  - Frederick T. Sheldon Mark T. Elmore and Thomas E. Potok, IEEE Proc. *International Conf. on Information Technology: Coding and Computing*, Las Vegas Nevada, pp. 500-506, April 28-30 2003
- **Dynamic Data Fusion Using An Ontology-Based Software Agent System**
  - Mark T. Elmore Thomas E. Potok and Frederick T. Sheldon, *7th World Multiconference on Systemics, Cybernetics and Informatics*, 2003
- **A Multi-Agent System for Analyzing Massive Scientific Data**
  - Joel W. Reed and Thomas E. Potok, *International Conference on Software Engineering*, 2003.
- **Suitability of Agent Technology for Military Command and Control in the Future Combat System Environment**
  - Thomas Potok, Laurence Phillips, Robert Pollock, and Andy Loebl, *8th International Command and Control Research and Technology Symposium*, 2003

National Challenge

- **Data everywhere**
- **Sources unreliable**
- **Difficult to merge**
- **Cannot be done manually**



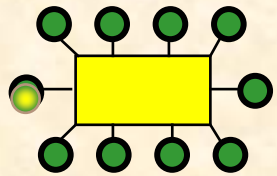
National Priorities

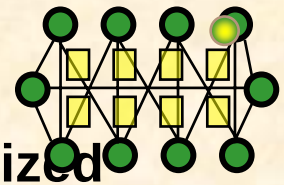


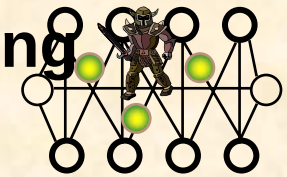
Future Combat System Future Force
Missile Defense
Home Land Security

Short History of Computer Science

- 70's Centralize mainframe computers
  - Computer, memory, storage in one place
- 80's Distributed computers, centralized databases
  - Computers on desktops, databases centralized
- 90's Internet, distributed computers and data
  - Computers and data distributed, processing centralized
- 00's Semantic web, distribute the processing
  - Computers, data, and processing distributed



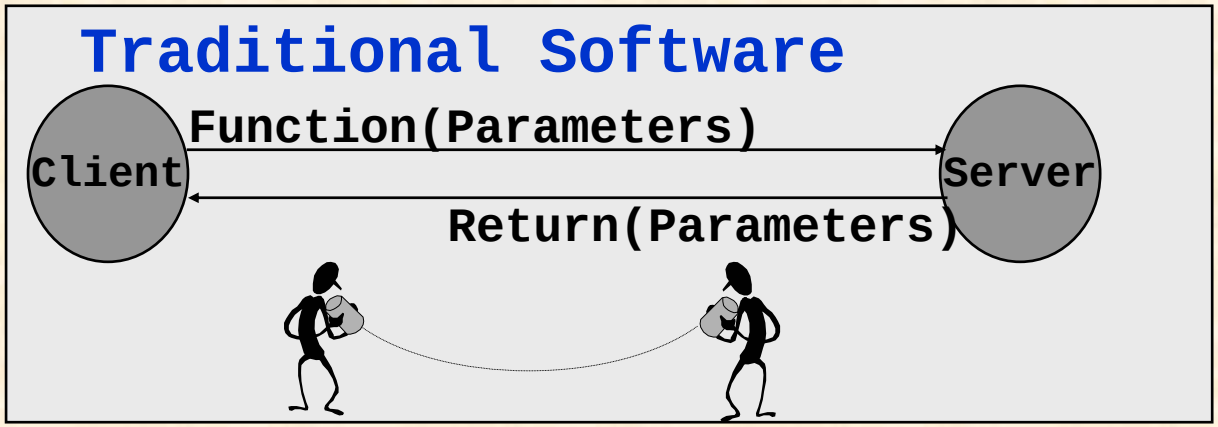




Outside of the box!

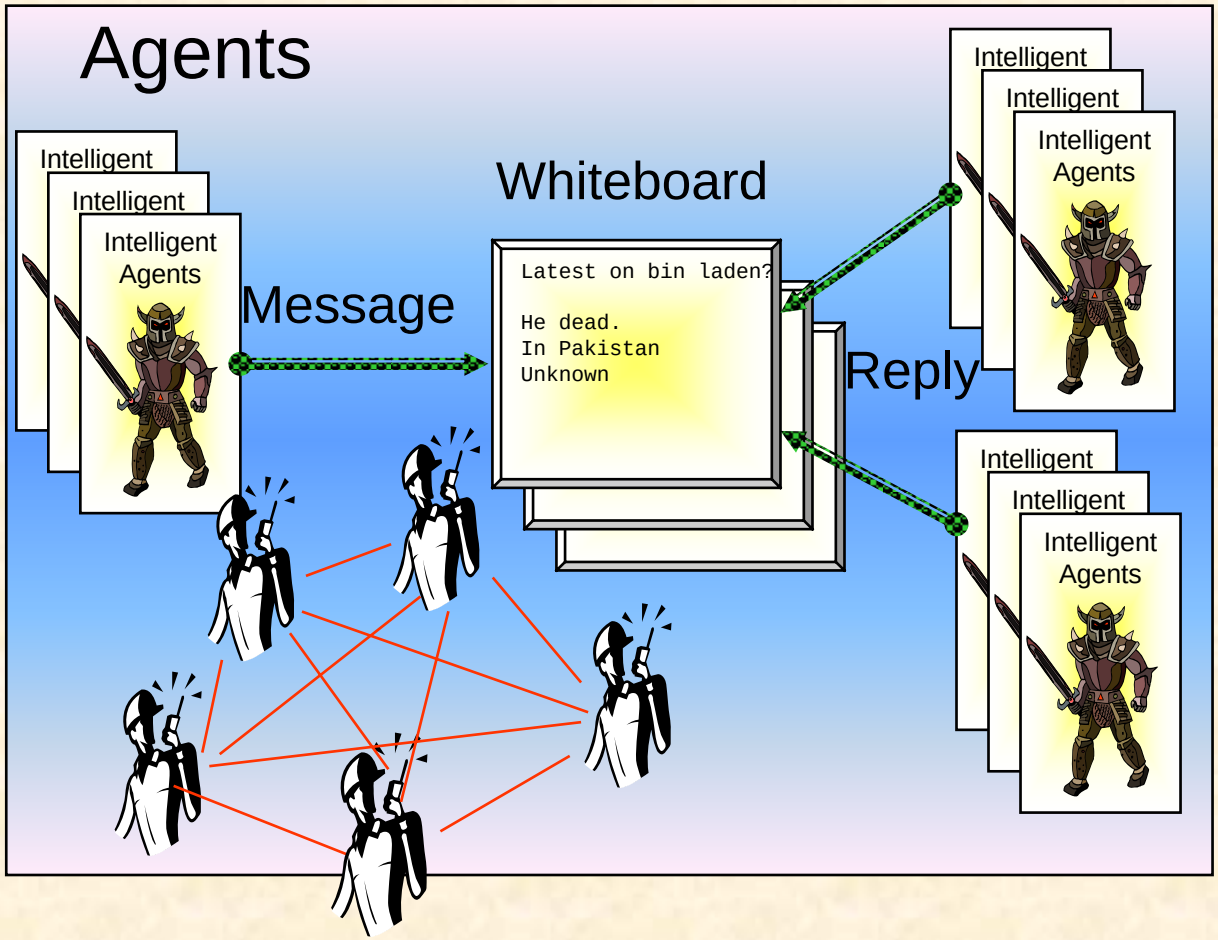
Current Approach

- Back to the 80's CENTRALIZE!!



- However, current approach
  - Move data for processing
  - Assume the network is available
  - Assume the data sources are reliable
  - Assume data is structured
- This will not work in today's environment

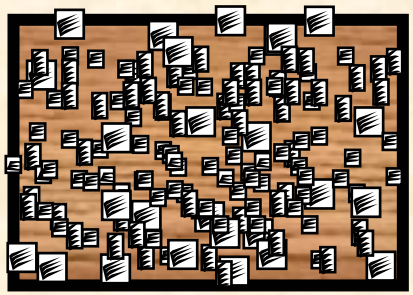
A New Agent Approach



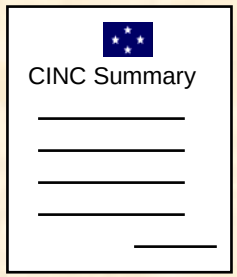
- **Agent Breakthrough**
  - **Move processing to the data**
  - **Works when network may not be available**
  - **Works when data sources may be unreliable**
  - **Works when data is unstructured**

Real Example: U.S. Pacific Command

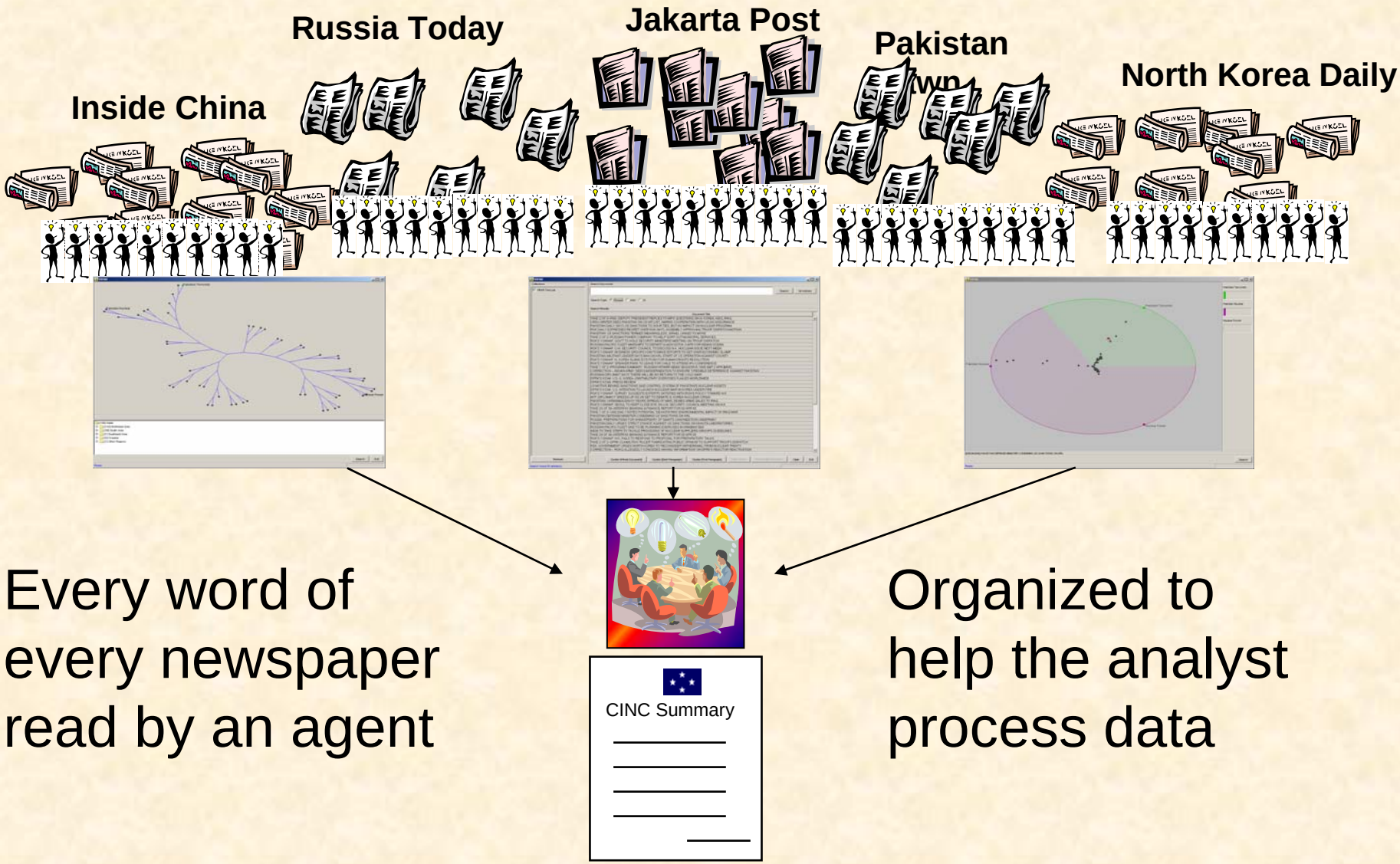
"Sipping from a firehouse"



"Great analysis, but from only 10% of the available data"



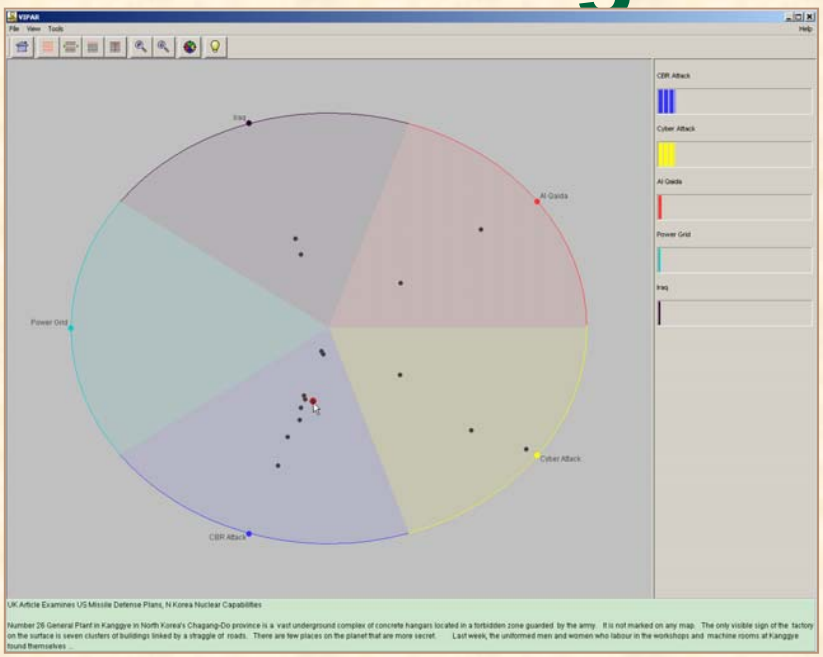
VIPAR Agent Approach



Every word of every newspaper read by an agent

Organized to help the analyst process data

VIPAR Agent Text Analysis



"Tremendously successful project"

"Software agents … lead to substantially improved analytical products."

"A grand slam home run!"

Software Agents "working at HQ USCINCPAC operationally."

US PACOM
Camp HM Smith, HI
Mike Reilley, Science Advisor

UNITED STATES INTELLIGENCE COMMUNITY

USS LaSalle
Flag Ship, COMSIXTHFLT
Mike Halloran, Science Advisor
CDR Chuck Pratt, N2

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Agent Architecture

Retrieve
- New images
- Newer images
- Higher resolution images

Process Images
- “Tag” meta data
- Store meta data in Mercury
- Store image in archive

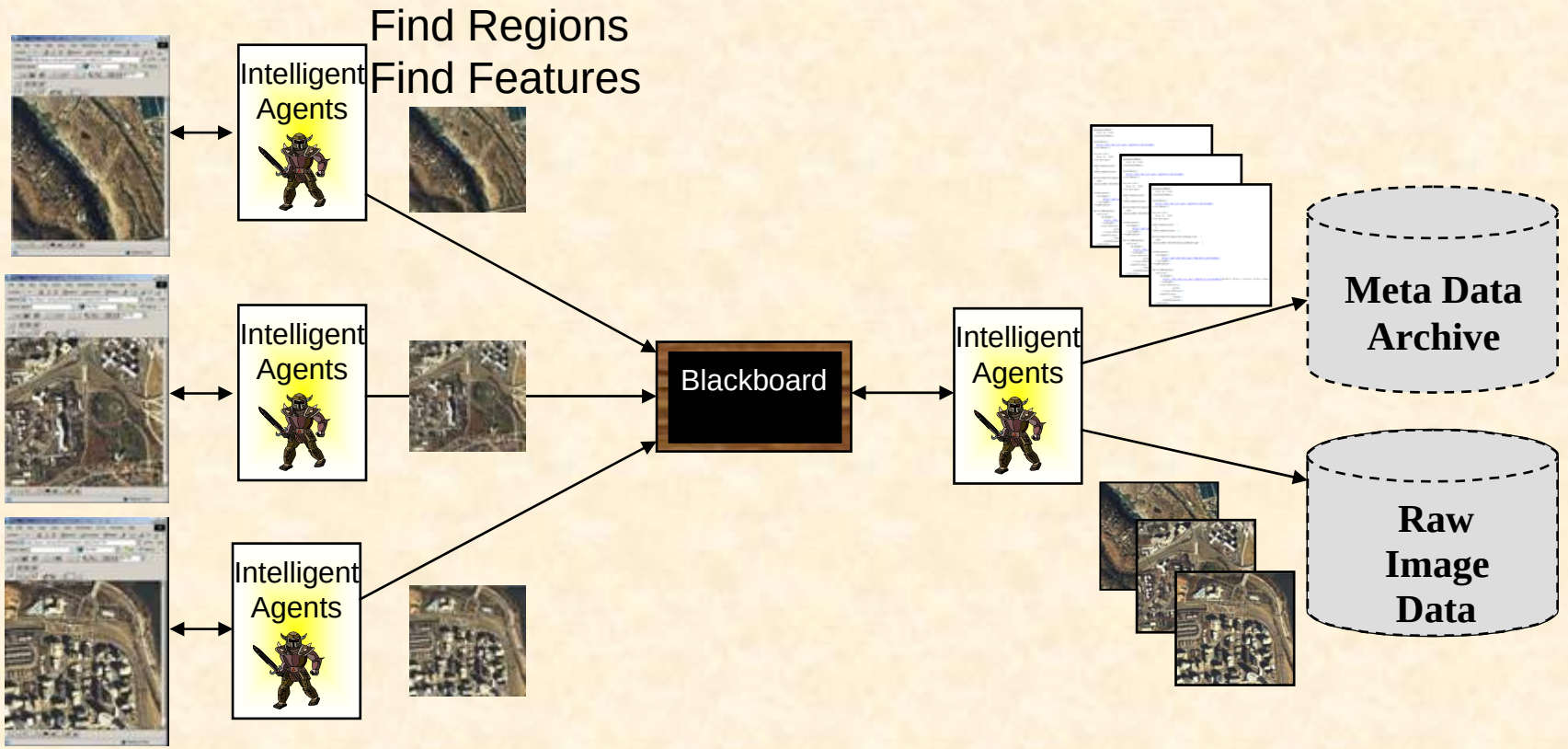
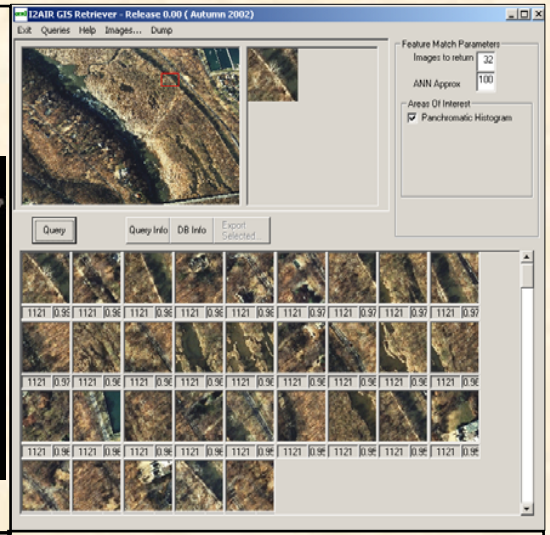


Image Retrieval

- **Users can begin to ask questions such as “find me buildings like these” and “show me what has changed at these sites over time”**
- **The example shows a demonstration of locating similar imagery within the image archive**

Select Region



History

2/23/2002
10 Meter

6/12/1997
30 Meter

High Resolution

Related Projects

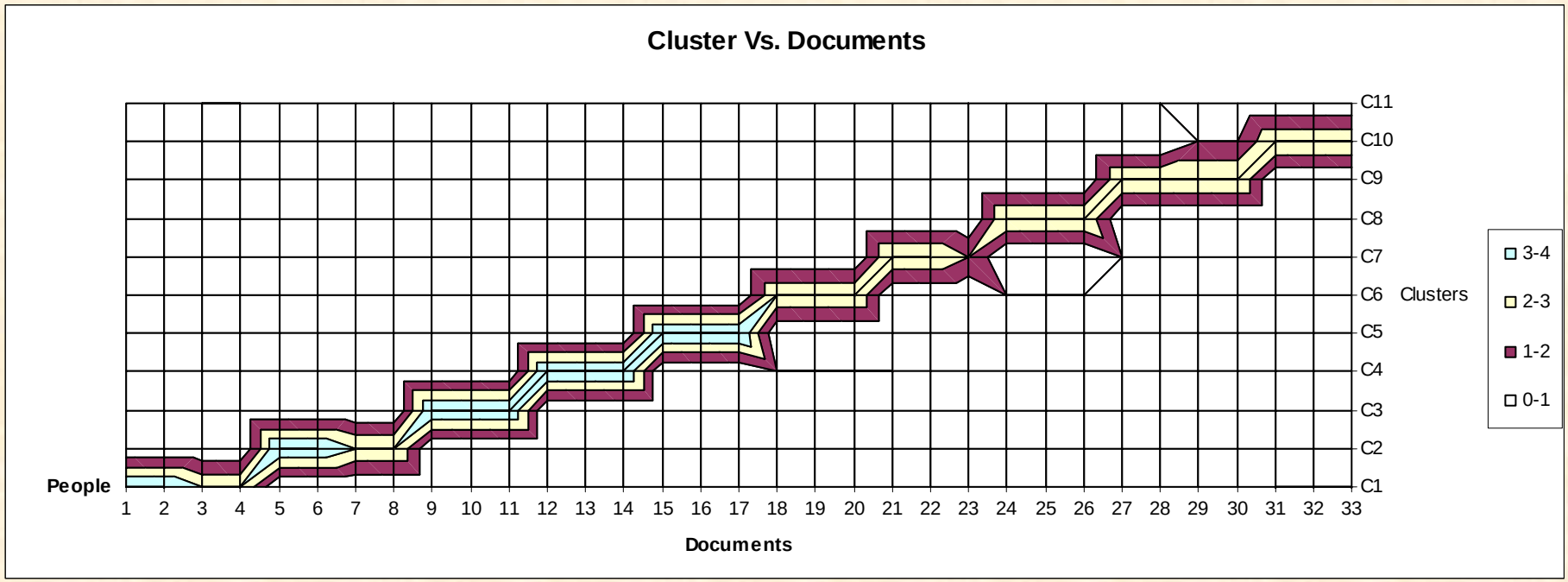
- Partnering with US Army RDECOM and Sandia to form Agent Center of Excellence
- Partnering with Sandia to build Advanced Decision Support System for the US Army
- Partnering with PNNL to bridge INSPIRE and VIPAR software tools

Piranha Preliminary Wo

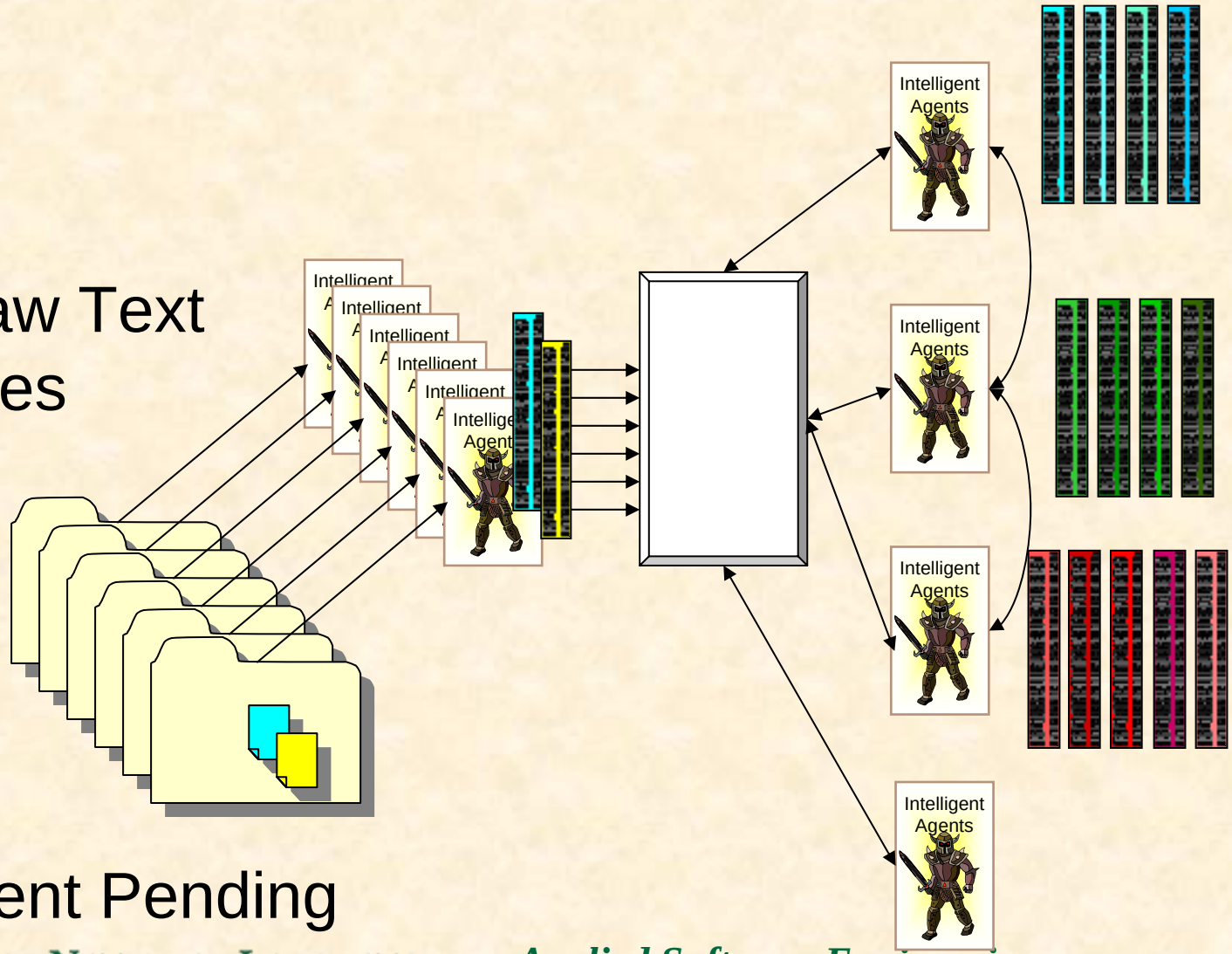
- Two key text clustering problems
  - Lack of a standard reference corpus
  - Computationally expensive ~ $O(n^3)$
- Base process
  - Create a vector space model relating terms to documents
  - Create a similarity matrix relating documents to documents
  - Create a cluster ranking tree (dendrogram) that shows the similar documents to each other

Manual Vs. Automated Clustering

- Reference set of 33 documents from TREC
- Four reviewers, 11 clusters
- Wide variation in manual sample



Piranha Dynamic Clustering



Patent Pending

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Preliminary Results

- Agent approach much faster
- More scalable
- Appears as accurate as traditional approaches

Comparison	Percentage Difference
Manual vs TFIDF	13%
Manual vs Agent	9%
TFIDF vs Agent	14%

Based on “A Multi-Agent System for Distributed Cluster Analysis” submitted to Software Engineering for Large-Scale Multi-Agent Systems (SELMAS'04)

Significant Scale Improvement

- Provides the capability to analyze enormous volumes of data, not available today
- Allows for a massively distributed or parallel platforms for analysis
- Allows for multi-agent systems to steer the analysis based on desired outcome

Next Steps

- Experiment with Piranha system on ORNL and LLNL supercomputers
  - Using TREC corpus determine where bottlenecks arise in agent architecture
- Explore the use of agents to traverse semantic graphs
- Connect textual analysis to semantic graph relationships

Summary

- Current technology cannot solve emerging national challenges
- Intelligent software agents are a significant breakthrough technology
- Results indicate high-potential to help solve these national challenges
- We have a progression of significantly successfully deployed agent systems and research to our credit

Contact Information

- **Contact Information**

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